Observations of the Spectrum of *o* Ceti in 1919

The spectrum of the long-period variable, *o Ceti*, was observed in the visual and ultra-violet regions during the 1919 maximum and decline to minimum. The purpose of this investigation was to determine the extent to which conclusions based on previous observations in the photographic region would be confirmed when extended to longer and shorter wavelengths, and to discover any additional features of interest in the star's spectrum. The observations in the visual region were made with 1-prism and 3-prism spectrographs attached to the 36-inch refractor of the Lick Observatory, while the observations in the ultra-violet region were made with the large quartz spectrograph designed by Mr. Wright for use with the Crossley reflector.

The most conspicuous features in the visual portion of the spectrum are the many and prominent absorption bands, over fifty having been measured between wavelengths 5550 A and 6700 A. All of these are sharp toward the violet and fade away gradually toward the red. Most of the bands in *o Ceti* of shorter wavelength than 5840 A, *i. e.*, in the yellow and blue, have been identified by Fowler with bands of titanium oxide. In the visual region, between 5500 A and 6700 A, as observed in the present investigation, there are no fewer than thirty coincidences with the band spectrum of titanium oxide. There remain twenty bands in *o Ceti* which apparently do not belong to this substance. Six of these have been found to coincide with bands which ordinarily occur in the arc spectrum of yttrium. Of these six, three coincide respectively with the first band in each of the three known groups in the yttrium band spectrum. While the origin of these bands can not be definitely attributed to yttrium, it is quite probable that bands due to yttrium in some form are represented in *o Ceti*. The remaining fourteen bands have not been identified.

It has been noted by previous observers that as *o Ceti* decreases in brightness, the absorption bands in the photographic region become stronger. This same effect was observed in the visual region during the 1919 decline to minimum. When the star had fallen 5.4 magnitudes below maximum, the absorption in some of the bands seemed to be complete. On a spectrogram secured at that time, the region about Hα was entirely burned out by overexposure, yet there was no trace of spectrum in the nearest heavy absorption band at 6200 A.

A relative strengthening of the red end of the continuous spectrum as *o Ceti* decreased in brightness was observed by Sidgreaves. This effect has been confirmed at the recent decline to minimum. A 1-prism plate was obtained in July, 1919, about the time of maximum, and a second in November after the star's light had decreased 3.7 magnitudes. On the latter date the spectrum at Hα was two or two and a half times as strong relative to the spectrum at 5200 A as on the former. This effect became even more pronounced as the star grew fainter. No marked changes in the ultra-violet continuous spectrum were observed, and in view of the fact that no absorption bands occur in this part of the spectrum, it may be suggested that the changes observed in the visual region are in some manner associated with the banded spectrum.

A remarkable feature of the Class Md spectrum is the presence of the Balmer hydrogen series as bright lines. The spectrograms of *o Ceti* obtained in 1919 showed all the hydrogen lines from Hα to Hρ, seventeen in number, to be bright. The strongest line of the series is Hδ. On either side of Hδ the intensities decrease, rather smoothly toward the red but irregularly toward the violet. The irregularities consist chiefly of abnormally faint lines, of which Hε is the principal example. This line is always faint in *o Ceti* and is frequently absent. It has been suggested that its faintness is due to absorption by the H line of calcium within whose limits Hε falls. Other conspicuous examples of abnormally faint lines are Hκ, Hλ, Hμ and Hξ. Of these lines the first three are nearly coincident with iron lines which are very prominent in the arc, and easily reversed. The conditions in *o Ceti* are favorable for the appearance of the iron arc lines as absorption lines. The fourth, Hξ, coincides in wavelength with a strong line of vanadium, an element which is prominent in the star's absorption spectrum. From these coincidences it seems not unlikely that this abnormal faintness of certain hydrogen lines is due to absorption by overlying metallic vapors. This explanation, if correct, would indicate a low level in the star's atmosphere for the hydrogen emission.

Another interesting feature in connection with bright hydrogen series is the abnormal displacement of the two lines, Hα and Hκ. Thruout the entire series of observations Hα was shifted about 1.2A toward the violet with reference to the other hydrogen lines. Hκ, on the other hand, exhibited a different behavior. In July, about one month before maximum light, it was shifted 1.1 A toward the

red, while in September, the displacement was 0.3 A toward the red. There is no obvious explanation for these anomalous displacements.

It is desirable that the visual and the ultra-violet spectra of *o Ceti* be studied at future maxima to determine in how far the behavior of the absorption bands and especially of the bright hydrogen lines, as observed in 1919, is repeated.

C. D. SHANE.

SUMMARY OF MOUNT WILSON MAGNETIC OBSERVATIONS OF SUN-SPOTS FOR MAY AND JUNE, 1920

Observations of the magnetic field in sun-spots were first made at Mount Wilson Observatory in 1908[1]. In the beginning only large spots could be observed, but as the methods and instruments were perfected it became possible to detect the polarity of very small spots. Since 1915 daily visual observations have been made of the magnetic field of all sun-spots for which such observations were possible.

The polarity can be determined when the line of sight is not too greatly inclined to the lines of magnetic force, which are perpendicular to the Sun's surface at the center of a spot. Near the Sun's limb polarity determinations are difficult for large spots, and impossible for small ones. The observations are made in the second order of the 75-foot spectrograph of the 150-foot tower telescope, usually with the iron line at λ6173.553. The method of observation and the scheme of classification according to polarity are described in detail, with illustrations, in the *Astrophysical Journal* for April, 1919, and in *Mount Wilson Contributions* No. 165.

The image of the Sun, 42.4 cm. in diameter, is projected upon a sheet of paper and a sketch of the spots is made. The approximate heliographic latitude and longitude of each group is read from a disk upon which the meridians and parallels of latitude have been drawn. The magnetic polarity and field-strength of each spot are then determined by the character of the polarization and the measured separation of the components of a Zeeman triplet.

These magnetic observations will be published in detail, probably in graphical form, but even after a complete scheme of periodical publication has been established, the installments will necessarily be some months late. Meanwhile it seems desirable to print regu-

[1]Hale, *Mount Wilson Contributions*, No. 30, *Astrophysical Journal*, **28**, 315, 1908.